

an optional active distance ranging function, enabling an individual or other audio source to be automatically focussed in accordance with time-of-flight principles. As such, not only does the invention provide a more faithful audio signal, but in addition, the use of active ranging solves problems associated with passive auto-focus systems, such as foreground disturbances and the frequent inability to distinguish between desired subject matter and background scenery.

In a preferred physical configuration of this embodiment, a camera is provided with a docking arrangement to receive the remote unit, as shown in FIG. 1A. Although FIGS. 1 and 2 will be described in conjunction with a consumer-type hand-held camcorder, the invention is equally applicable to both moving and still image gathering in industrial and professional configurations as well. Both stereo and mono audio recording are also readily accommodated by the invention, with the remote unit both in its docked and undocked configurations.

In FIG. 1A, a camera 102 has physically received a remote unit 104 containing a microphone, and an electrical path is formed through a set of electrical contacts not visible in this figure between the camera and remote unit. Preferably, in this configuration, with the remote unit 104 docked as shown, certain facilities associated with remote operation are defeated (if activated) to save on battery power, and with the microphone delivering an audio signal to the camera in hard-wired fashion.

In FIG. 1B, the remote unit, now labeled 104', has been removed from the docking facility provided on the camera 102, facilitating at least a remote microphone capability. Preferably, the wireless link to the camera is RF in nature, and may be use FM or other modulation techniques and any allocated frequency. An optical or IR link may also be used. Thus, with the microphone 104' removed and this mode of operation activated, audio information detected at the microphone is no longer delivered to the camera 102 in hard-wired fashion, but, instead, is transmitted via a wireless signal 106 to the camera body. In the case of an RF signal the camera body may be equipped with an antenna 110 which, conveniently, may be exposed upon removal of the microphone from its docked position. Also shown in FIG. 1B are contacts 108 between the camera 102 and remote unit 104, these contacts having been exposed upon removal of the microphone from the docking station.

Activation of the remote configuration may be carried out through switches on the microphone, or on the camera body, or both. Alternatively, remote operation of the microphone may automatically be activated through the removal of the microphone from its docked position, for example, by sensing an electrical or mechanical condition, thereby foregoing the need for manually operated switches.

According to the remote mode of operation, the unit 104' transmits a wireless signal modulated with audio information in a manner similar to conventional remote microphones, but with several notable differences. Firstly, virtue of the docking capability, a rechargeable battery in the microphone 104 may be automatically charged through the battery of the camera through contacts between the camera and remote unit. Thus, by docking the remote onto the camera 102, a separate recharger stand need not be provided according to the invention. Another difference is that, as discussed above, even with the remote mode of operation having been selected, with the microphone docked onto the body of the camera 102, this mode of operation is preferably automatically defeated to save on battery power.

As a further difference relative to conventional, non-integrated remote microphones, the directionality of the inventive microphone may be made to change from a broad angle of pick-up when docked to a relatively narrow angle of pick-up when removed. This is preferred, since, with the remote unit docked on the camera, particularly with a wide-angle visual field-of-view, a broad range of audio reception may be desirable. In contrast, with the microphone removed and placed relative to an individual being recorded, for example, a relatively narrow angle of reception may be more preferable. As discussed further with reference to FIG. 2, this switching in directionality may be accomplished manually or automatically, as by sensing an electronic or mechanical condition.

In addition to its use as a remote microphone, the unit 104' may also be used in conjunction with a suitably equipped camera to provide an active distance auto-ranging function based upon time-of-flight. Although the same or a different RF frequency or optical link may be used for such purpose, in a preferred embodiment the camera is designed to broadcast an inaudible acoustic signal which is received by the remote unit 104' and relayed back to the camera in wireless fashion for the purpose of performing a distance determination. An acoustic signal such as an ultrasonic signal is preferred due to its relatively lower speed of propagation and greater ease with which a distance calculation may be performed. To limit power consumption, and to simplify the distance determination, a series of acoustic pulses are preferably generated on a periodic basis, having a frequency as low as 20 kHz, and a repetition rate as low as one or fewer pulses power second. Clearly, it is well within the scope of the invention to use higher or lower frequencies and/or repetition rates.

Having received a transmitted signal from a suitably equipped camera, the remote unit 104' relays a transponding signal back to the camera and, based upon the difference between the signal sent and that received, distance is determined within the camera, and an output signal is coupled to an auto-focus circuit, which may be of otherwise conventional design. Although a different RF or optical frequency may be used for the auto-focus signal relayed back to the camera, in the preferred embodiment, the same carrier as that used for the remote microphone is used to carry the auto-ranging signal, thereby obviating the need for a separate transmitter/receiver pair.

Much of the circuitry used to gather and modulate the remote audio signal may be used to gather and modulate the inaudible acoustic signal transmitted by the camera, thus simplifying the circuit configuration while providing for a more cost-effective arrangement. If the audio pick-up used for the remote microphone capability is also capable of receiving the inaudible acoustic signal from the camera used for auto-focus purposes, even the same microphone may be used for both audio pick-up and reception of the ranging signal for auto-focussing purposes.

FIG. 2A is a block diagram which illustrates major functional components associated with a remote unit according to the invention. A set of electrical contacts 206, which are illustrated commonly between FIGS. 2A and 2B, are used to communicate electrical signals between the camera and the remote unit. An audio pick-up 208, which may be contained within a physical receptacle 209, delivers an audio signal to a selection circuit 212 controlled by a central-processing unit (CPU), which may take the form of a microprocessor or single-chip microcomputer, whether of standard or custom derivation.

A separate microphone 210 may be added and selected by block 212 in order to modify directionality. That is, for a